IS GRAPHITE A CERAMIC?

What is a ceramic?
1. Something that is made of clay and fired
2. A material that is hard, brittle, thermal and electrical insulator, opaque, high melting point, good in compression [this is the definition a pupil might give]
3. A material that is inorganic and non-metallic [this true definition is not based on properties]

What is graphite?
2. Brittle ✓
3. Conducts electricity* – Ionic conductors are used in fuel cells and are ceramics
4. Conducts heat* – ceramics are used for cooker hobs
5. Opaque ✓
6. High melting point ✓
7. Good in compression ✓

*These are not actually defining properties of a ceramic. They are dependent on bonding.

Therefore:
- Based on the pupil definition graphite may be a ceramic.
- Based on the true non-property based definition graphite is a ceramic as it is not organic and not metallic.

Graphite is used in the following applications:
- Electrodes for the electrolysis of aluminium and for the generation of heat in the electric arc furnace for the production of steel.
- Neutron moderator in thermal nuclear reactors. The neutron moderator slows fast neutrons, typically travelling at 10% of the speed of light to thermal neutrons, travelling at a few kilometres per second. These thermal neutrons are capable of sustaining a nuclear chain reaction.
- Pencil 'lead'. Graphite has a structure made up of sheets of atoms which can easily slide across each other and be separated, thus leaving a mark on paper. For the same reason graphite can also be used as a lubricant to high temperatures.

In the 1920s a paper was published by the American Glass Society on the definition of ceramics: www.acers.org/acers/aboutceramics.asp

What is hardness?
Hardness can be defined in a number of ways but it is basically the resistance of a solid material to a shape change when a force is applied. Three types of hardness can be used:
- **Scratch hardness** is the resistance of a material to plastic deformation due to friction from a sharp object. Scratch hardness is often used in mineralogy where a harder material is used to penetrate a softer material. The Mohs Hardness scale ranks natural materials based on their ability to scratch and be scratched by each other, where 1 is the softest material and 10 is the hardest material.
  - 1 Talc, 2 Gypsum, 3 Calcite, 4 Fluorite, 5 Apatite, 6 Orthoclase, 7 Quartz, 8 Topaz, 9 Corundum, 10 Diamond
- **Indentation hardness** is the resistance of a material to plastic deformation due to a constant load from a sharp object. This is the most commonly used definition of hardness in materials engineering and a number of scales are available. Vickers hardness has a very wide range of values and is measured by pushing a pyramid-shaped diamond into the surface of a polished material using a known load (e.g. 5, 10 or 20 kg). The size of the indentation produced is measured and this correlates to a hardness value.
- **Rebound hardness** is measured as the height of bounce of a diamond tipped hammer dropped on to the surface of the material from a fixed height.